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FEDERAL GOVERNMENT DEBT AND INFLATION: EVIDENCE FROM GRANGER CAUSALITY TESTS

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1. Introduction

A topic of heated debate among economists and policymakers is the affect of federal debt on the economy. The recent surge in the debt has fueled this debate, with the conventional wisdom pointing to dire consequences in terms of higher interest rates, lower productivity and higher rates of inflation.[1] A closely related issue is the policy response by various governmental agencies to this threat.

Recent experience has mitigated some of the trust behind these warnings.[2] Recent developments have not, however, lessened the fear among some economists that persistent deficits eventually must be financed through monetization by the Federal Reserve. If such an action takes place, then the debt will be inflationary. Indeed, this transmission mechanism from debt to inflation has been the basis for many studies.[3]

Our purpose in this paper is to provide further evidence on the empirical relationship between the debt and inflation for the United States during the period 1950-1984. To capture the government's indebtness, we use a measure of the market value of government securities, presented in Cox (1985b), and a par value measure. These measures allow us to directly test the effects of government debt on inflation. To study the connection, we use the Granger-causality framework. Unlike previous studies using similar procedures, however, we recognize our inability to adequately determine the "true" lag structure underlying the model. Thus, we use the general framework suggested by Thornton and Batten (1985) to survey the causal relationship over a wide variety of lag structures. As an additional modification on the Granger-causality framework, the long-run effects also are examined.

2. Debt and Inflation: The Theories and Existing Evidence

Competing theories on the relationship between government debt and inflation provide no clear answer on what the empirical outcome should be. Sargent and Wallace (1981) offer a model in which an increase in the stock of public debt must produce faster money growth in the future. Cox (1985a) argues that in a regime of permanent government debt -- that is, one in which the debt never is retired fully -- increases in debt have inflationary effects similar to a debt monetization policy. Others suggest that increases in debt increase the real value of existing government bonds and net wealth. This increases aggregate spending and, ceteris paribus, the price level. Examples of this scenario are the models of Patinkin (1965) and Smith (1982).

Monetarists contend that deficits are inflationary only to the extent that the Federal Reserve purchases the newly issued bonds in an attempt to offset the presumed increase in interest rates that would otherwise accompany such an action. This policy effect on the Fed is the basis for a very large and, to date, unsettled literature. For example, Hamburger and Zwick (1981) and Allen and Smith (1983) find some degree of positive association between federal deficits and the growth of M1 or high-powered money during the post-war period. In contrast, Dwyer (1982) and King and Plosser (1985) examine roughly the same sample period and find little statistical reliability in this link. Joines (1985) rejects the link between nonwar government deficits and the growth of the monetary base based on data from the period 1872 to 1983.

An argument due to Barro (1979) hypothesizes that deficits are a result of inflation, thus providing an alternative reason for any observed

positive correlation between the two series. The idea underlying this view is that the government's concern is with the real value of its debt. If this is true, an increase in the anticipated inflation rate necessitates an increase in the nominal value of bonds. To keep the real value of the debt from falling, the nominal debt increases -- the government runs a deficit -- in pace with anticipated inflation.

3. The Methodology

The aim of this paper is to apply traditional Granger causality tests, examining the temporal linkage between inflation and government debt.[4] The standard reduced-form, bivariate model on which the Granger test is based can be expressed as

$$P_t = L(\pi_{11})^y P_{t-1} + L(\pi_{12})^x B_{t-1} + \mu_{1t}$$

(1)

$$B_t = L(\pi_{21})^y P_{t-1} + L(\pi_{22})^x B_{t-1} + \mu_{2t},$$

where $L(.)^j$ denotes the polynomial lag operation of order j (e.g., $L(\pi_{21})^j P_{t-1} = \pi_{21,1} P_{t-1} + \pi_{21,2} P_{t-2} + - - - + \pi_{21,j} P_{t-j}$), P and B are jointly determined endogenous variables (inflation and the growth of federal debt), and μ_1 and μ_2 are assumed to be $\underline{iid}$ $(0,\sigma^2 i)$, i=1,2. The πs are nonlinear functions of the structural parameters.

To test for Granger causality between P and B, the following hypotheses are tested: $L(\pi_{12})^x = 0$ and $L(\pi_{21})^y = 0$. If $L(\pi_{12})^x = 0$ is rejected but $L(\pi_{21})^y = 0$ is not, there is unidirectional causality running from B to P. If $L(\pi_{21})^y = 0$ is rejected and $L(\pi_{12})^x = 0$ is not, however, unidirec-

tional causality runs from P to B. If both hypotheses are rejected, there is bidirectional causality and if neither are rejected, the two series are independent.

Thornton and Batten (1985) have shown that the Granger test procedure depends critically on the selection of lag parameters x and y. In this regard, a concern about previously reported evidence is the sensitivity of the conclusions to the choice of lag length.[5] Rather than using some of the various criteria suggested to select the appropriate lag length, the lag length's of x and y are allowed to vary over a range from 1 to 12. In this regard, the robustness of the evidence is easily summarized.

As an additional modification of the traditional Granger-causality framework, the long-run effects also are examined here. Traditional tests consider only the joint hypothesis,

$$(2) \quad \pi_{ik,1} = \pi_{ik,2} = - - - = \pi_{ik,j} = 0 \text{ for } i=1,2;\ k=1,2 \text{ and } i \neq k.$$

This hypothesis could be rejected if any of the individual coefficients are significantly different from zero. Moreover, the joint hypothesis could be rejected if the sum of the coefficients was zero, with those coefficients that are positive being offset by other coefficients that are negative.

It is our contention that, tests should be made on the long-run effects.[6] The pattern of the lag coefficients also is of interest. It is important to discriminate between the case where a variable Granger-causes another by unequivocally leading to either higher (or lower) values of the other variable from the second case where a variable Granger-causes another

by first leading to its rise (decline) and later leading its fall (rise).

Insight allowing us to discriminate between these two cases can be gained by testing the hypothesis

$$(3) \quad \pi ik,1 + \pi ik,2 + - - - + \pi ik,j = 0 \text{ for } i=1,2;\ k=1,2 \text{ and } i \neq k.$$

Inability to reject hypothesis (3) suggests that the long-run predictive effect of variable k on variable i is zero. That is, knowing that variable k has permanently increased by 1 percent, provides no predictive information about the long-run value of variable i. Rejection of the hypothesis (3), however, suggests that there is a permanent effect running from variable k to variable i. Rejection of (3) can occur either because of a permanent positive or negative effect.

In the following section we consider the temporal relationship between government debt and inflation. Both the joint hypothesis (2) and the individual hypothesis (3) are tested.

4. Statistical Tests of Granger Causality between the Market Value of Government Debt and Inflation

The primary debt variable used in this study is the market value of privately held federal government debt.[7] The inflation variable is measured by the Consumer Price Index. Both variables are quarterly averages of not seasonally adjusted monthly measures. The log differences of each variable was used to provide stationarity of the underlying series.

Table 1 provides evidence on Granger-causality running from the market value of government debt to inflation. The table reports F-

statistics for the null hypothesis (2), testing whether lags on federal debt contribute to the explanation of inflation, given lags on inflation. The results illustrate Thornton and Batten's concern that the evidence on Granger-causality is highly sensitive to the lag length chosen. For example, the null hypothesis is not rejected, (at the 5 percent level),if one arbitrarily choses both lags to be four. On the other hand, if one choses both lag lengths to be eight, the hypothesis is rejected.

The evidence in table 1 suggests that knowledge of past debt behavior is useful in predicting today's inflation. There are 44 instances in which the null hypothesis is rejected at the one percent significance level and only 31 cases where the null is not rejected at the five percent level. While the evidence is clearly not without exception, it suggests that knowing past increases in federal debt may be useful in predicting today's inflation. This evidence is supportive of the hypothesis that debt "causes" inflation.

Table 2 considers the reverse hypothesis, that knowledge of past inflation is useful in predicting federal debt. Rejection of this joint hypothesis is not nearly as dependent on the choice of lag length: as long as three or more lags are included for both variables, the joint hypothesis is rejected without exception. In this regard it appears that inflation is useful in predicting federal government debt.[8] Thus, the evidence suggests that there is bidirectional causality between the market value of privately held federal debt and inflation.

4.a The Long-Run Relationship: Inflation on Debt

To determine the long-run reduced-form responsiveness of inflation to debt growth, the following relationship is estimated,

$$(4) \qquad P_t = \alpha_o + \sum_{i=1}^{K} \pi 11,i \cdot P_{t-i} + \sum_{j=1}^{L} \pi 12,j \cdot B_{t-j} + \mu 1t.$$

The long-run elasticity is then given by

$$(5) \qquad N = \left(\sum_{j=1}^{L} \pi 12,j \; / \; 1 - \sum_{i=1}^{K} \pi 11,i \right).$$

Table 3 provides a summary of the point estimates of the long-run elasticity of inflation to a change in debt growth, for the various lag length choices considered in table 1. The evidence in table 3 suggests that the long-run reduced-form response of inflation to a permanent change in debt is not quantitatively large. In fact, over one third of the point estimates are negative. The negative long-run effect generally is associated with a negative coefficient on the first debt lag variable. The coefficient on this particular variable is negative in all 144 equations and is almost always significantly different from zero at the five percent significance level.

This negative relationship between last quarter's debt and this quarter's inflation may surprise those who associate increasing debt with increasing inflation. Yet, the negative relationship does have a plausible explanation. Because the debt variable is the market value of privately held debt, it moves in a direction opposite to market interest rates. In this light, the market value debt measure reflects not only new issuance

of government debt, but also reflects short-term movements in interest rates.

Fama (1975), Fama and Gibbons (1984) and Hafer and Hein (1985) have shown that interest rates on short-term Treasury bills contain fairly accurate forecasts of tomorrow's inflation. In particular, Hafer and Hein find a significant positive association between the current end-of-quarter Treasury bill rate and next quarter's inflation. To the extent that the today's market value of debt reflects (in a negative fashion) movements in today's short-term interest rates, today's market value of debt also reflects tomorrow's inflation in a negative fashion. Based on the simple Fisherian relationship, if market participants expect higher inflation next quarter, the nominal interest rate on government securities will be driven up today, lowering the market value of all existing fixed-income securities. To the extent that market expectations are fulfilled, declines in the market value of debt should preceed increases in inflation.

The long-run effect is not always negative, indicating that the initial, negative effect is offset by a subsequent positive association between inflation and longer lags on debt. Such evidence cautions against concluding that there is a positive or negative causality running from one variable to another, without performing additional tests.[9]

Because the long-run elasticity parameter is a nonlinear combination of ordinary least squares esimates, it is difficult to test it's size. It is, however, easy to test the hypothesis that the sum of the lagged debt coefficients is equal to zero. Inability to reject this hypothesis is sufficient to conclude that the long-run effect is zero, as indicated by (5).

Table 4 reports the results from testing the hypothesis that the sum of the coefficients on the lagged debt variables is zero. Even though this statistic is reported for all 144 possible combinations of lags on debt and inflation, there are only four cases in which the null hypothesis is rejected. Thus, the pattern of the coefficients generally is such that the coefficients on the first few lags are negative and are offset by positive coefficients on longer lags. This pattern is clearly not consistent with the hypothesis that increases in government debt Granger-cause permanent increases in inflation. While past debt appears to influence today's inflation, the long-run effect is not positive. In fact, in the four cases in which the zero sum-effect is rejected, the long-run elasticity is estimated to be negative.

4.b The Long-Run Relationship: Debt on Inflation

Table 5 provides the point estimates for the long-run responsiveness of debt to changes in inflation. In contrast to the parameter estimates in table 3, all of the point estimates are positive, exceed unity and are often close to two. This outcome suggests that a permanent one percent increase in inflation is associated with a greater than a one percent permanent increase in the growth rate of debt.

We also tested the hypothesis that the sum of the coefficients on lagged inflation are zero. The test statistics are presented in table 6. The results almost universally lead to a rejection of the null hypothesis: in 140 of the 144 cases the null hypothesis is rejected. In fact, our finding of significant positive effects provides strong support for Barro's hypothesis that the positive association observed between debt and infla-

tion during the post-war period stems from the effects of inflation on debt, not from debt on inflation as often hypothesized.

5. Granger Causality: Par Value of Debt and Inflation

Evidence in the prior section provides little support for the claim that increases in debt lead to permanent increases in inflation, at least as far as the post-war U.S. experience is concerned. Those who make such a claim may discount this evidence, however, since it is based on the examination of the market value of privately held debt. It could be argued that the lack of a long-run, positive association is due to the aforementioned anticipated interest rate response. The expected positive association would be more easily identified if a par value debt series was be employed.

To examine such a claim, Granger causality tests were run between inflation (again measured by the Consumer Price Index) and the par value of privately held federal debt. The primary difference in the two debt series is that the par value series is not immediately affected by a change in interest rates.

The same methodology employed in examining the Granger causality between inflation and the market value of debt was used to examine the Granger causality between inflation and the par value of debt. Using the par value series, the conclusions about Granger-causality were almost independent of lag length selection. First, consider the issue of whether the par value of debt Granger-causes inflation. Of the 144 test statistics only 3 were significant at the 5 percent level when the significance of lagged debt was considered. Thus, there is very little evidence that the par value of debt

Granger-causes inflation. The rejection rate is even less than the critical level, since the 5 percent level would imply about 7 false rejections. The issue of long-run responsiveness is moot, then.

When the significance of lagged inflation in explaining the growth of par value debt was tested, the null hypothesis of independence was rejected at the 5 percent level 130 out of the 144 possible times. This evidence again is consistent with Barro's hypothesis that increases in inflation lead to increases in federal debt. The long-run relationship also was found to be uniformly positive and the elasticity was usually close to unity.

6. SUMMARY

This paper has investigated the Granger-causality relationship between inflation and privately held federal government debt. Particular attention has been paid to the choice of lag length and the long-run lagged relationship between these variables. While specific conclusions depend on the choice of lag length, the bulk of the evidence favors the conclusion that there is bi-directional causality between inflation and the market value of privately held federal government debt.

No evidence was found supporting the hypothesis that an increase in the growth of this debt series lead to permanent increases in inflation. The pattern of coefficients representing the lagged effect of debt on inflation indicated that increases in debt are first associated with decreases in inflation. This initial short-run negative relationship is completely consistent with the forward looking Treasury securities market,

as developed by Fama (1975) and Fama and Gibbons (1984). Moreover, the results also show that, in the long-run, the effects of changes in the market value of debt on inflation generally are not significantly different from zero.

This paper also found very little evidence that the par value of privately held federal debt Granger-causes inflation. On the other hand, there was much evidence consistent with the Barro hypothesis that inflation leads to increases in the federal debt, either par value or market value.

Footnotes

1. For an overview of the literature, the reader is referred to the recent Treasury study (1984). For a recent study that focuses on the 1980s, see Tatom (1985). Dewald (1985) provides a methodological critique of previous uses of the deficit data.
2. As Tatom notes, recent behavior of nominal interest rates do not match the prediction of conventional wisdom. For instance, interest rose sharply prior to the increase in the deficit (as a percent of GNP) in the early 1980s and fell in 1982 as the deficit continued to use. Moreover, private domestic investment (as a percent of GNP) has risen sharply during the past few years relative to historical standards.
3. For a discussion of this issue, see Hein (1981)
4. Cox (1985a) performed "Granger-Sims" causality tests linking the rate of change in the consumer price index and the rate of change in the market value of privately held federal government debt. The evidence provided by Cox did not consider bidirectional causality. To conclude that debt caused inflation, Cox estimated the following relationship.

$$(1)\quad P_t = \beta_0 + \beta_1 P_{t-1} + \beta_2 P_{t-2} + \beta_3 P_{t-3} + \sigma_1 B_{t+2} + \sigma_2 B_{t+1} + \sigma_3 B_t + \sigma_4 B_{t-1} + \sigma_5 B_{t-2} + - - - \sigma_9 B_{t-6} + \varepsilon_t,$$

where P_t is the (adjusted) growth rate of inflation at time, t, and B_t is the (adjusted) growth rate of market value of privately held federal government debt at time, t. When Cox rejected the hypothesis:

$$(2)\quad Ho: \sigma_1 = \sigma_2 = - - - = \sigma_9 = 0,$$

he concluded that he could not reject the hypothesis that "an increase in the outstanding stock of Treasury notes is inflationary" (p. 22). For those familar with Granger-Sims tests, it is not obvious that such a conclusion is justified. For one thing, Cox fails to differentiate between the statistical significance of the lead, lag or contemporaneous debt variables, yet such an issue is vital to the Granger-Sims methodology.

5. For example, Dwyer's (1982) use of a VAR system imposes equal lag lengths on each of the independent variables. Even though he tested for significance of 4 lags against 8 lags and could not reject the shorter lag structure tests as adequate, Thornton and Batten (1985) suggests that such restrictive tests often are misleading.

6. It should be emphasized here that tests on the π_{ik} parameters are tests on reduced form coefficients, not structural coefficients. As Jacobs, et al. (1979) aptly point out, Granger-causality tests do not allow one to make comments about the underlying structure. In this regard, testing the long-run relationship considers only the predictive ability enhanced by knowledge of the past behavior of the "causal" variables.

7. See Cox (1985b) and Cox and Hirschhorn (1983) for a description of the data and construction of the market value series. We would like to thank Mike Cox for providing an updated version of this series.

8. This finding provides some support for Barro's (1979) hypothesis.

9. Cox, for example, concluded that he could not reject the hypothesis that an increase in the outstanding stock of Treasury notes is inflation. In point of fact, by not testing the long-run relationship Cox

did not test this hypothesis. He only tested causality, which has no bearing on the direction of the effect.

10. The results of these tests using par value debt measures are available from the authors upon request.

Table 1. F-Statistics: Does Debt Granger-Cause Inflation?

Lags on Inflation \ Lags on Debt	1	2	3	4	5	6	7	8	9	10	11	12
1	0.72	4.28*	2.78*	----	2.69*	2.24*	2.15*	2.74*	2.75*	----	2.52*	2.87*
2	1.94	4.79*	3.23*	1.91	2.88*	2.73*	2.58*	2.85*	3.02*	2.93*	2.62*	3.01*
3	4.22*	4.36*	3.11*	1.80	3.96*	3.93*	3.31*	3.28*	3.22*	----	2.60*	2.66*
4	1.11	2.19	1.57	1.44	2.24	2.33*	1.97	2.60*	2.57*	2.34*	2.25*	2.35*
5	2.93	2.43	1.89	2.02	2.32*	2.29*	1.93	2.56*	2.49*	2.26*	2.14*	2.30*
6	2.86	2.47	2.07	2.23	2.73*	2.26*	1.93	2.46*	2.40*	2.22*	2.10*	2.25*
7	2.53	2.38	2.15	2.53*	2.90*	2.41*	2.11*	2.64*	2.54*	2.38*	2.15*	2.27*
8	2.91	3.37*	2.68*	3.40*	4.23*	3.55*	3.01*	2.82*	2.66*	2.60*	2.33*	2.30*
9	3.44	2.71	2.12	2.75*	3.55*	2.97*	2.52*	2.39*	2.30*	2.16*	1.92*	1.94*
10	4.54*	3.73*	2.63	2.89*	3.58*	2.96*	2.54*	2.35*	2.18*	1.97*	1.80*	1.86*
11	6.01*	4.13*	2.90*	2.73*	3.41*	2.82*	2.45*	2.19*	2.04*	1.86	1.74	1.86*
12	6.47*	4.35*	3.07*	2.73*	3.56*	2.94*	2.53*	2.31*	2.26*	2.05*	1.94*	2.01*

* significant at the 5 percent level.

Table 2. F-Statistics: Does Inflation Granger-Cause Debt?

Lags on Debt \ Lags on Inflation	1	2	3	4	5	6	7	8	9	10	11	12
1	5.29*	2.55	6.28*	5.13*	4.36*	3.93*	6.30*	5.55*	5.10*	4.74*	4.71*	5.06*
2	5.22*	2.59	5.69*	4.71*	3.83*	3.42*	5.65*	4.98*	4.59*	4.33*	4.31*	4.79*
3	5.06*	2.60	5.82*	4.60*	3.91*	3.34*	5.00*	4.50*	4.02*	3.57*	3.45*	3.83*
4	5.85*	3.06	5.77*	4.89*	4.12*	3.47*	4.98*	4.52*	4.00*	3.56*	3.42*	3.80*
5	6.00*	3.12*	5.80*	4.71*	3.99*	3.36*	4.83*	4.39*	3.90*	3.47*	3.34*	3.80*
6	6.25*	3.10*	5.90*	4.62*	4.03*	3.34*	4.79*	4.35*	3.87*	3.44*	3.33*	3.77*
7	5.98*	2.96	7.37*	5.76*	5.40*	4.65*	4.82*	4.42*	3.93*	3.51*	3.40*	3.74*
8	5.31*	2.67	6.88*	5.96*	5.60*	4.68*	4.82*	4.35*	3.86*	3.47*	3.38*	3.65*
9	3.91	1.99	7.02*	5.84*	5.10*	4.26*	4.40*	3.90*	3.58*	3.27*	3.26*	3.40*
10	4.54*	2.32	7.61*	6.02*	5.35*	4.42*	4.62*	4.03*	3.60*	3.22*	3.22*	3.36*
11	4.54*	2.31	7.45*	5.94*	5.23*	4.32*	4.90*	4.36*	3.89*	3.55*	3.20*	3.34*
12	5.12*	2.57	8.83*	6.92*	5.98*	4.94*	5.56*	4.82*	4.43*	4.00*	3.64*	3.64*

* significant at the 5 percent level

Table 3: Long-run Elasticity Parameters: Responsiveness of Inflation to a Permanent Change in Debt

Lags on Debt / Lags or Inflation	1	2	3	4	5	6	7	8	9	10	11	12
1	-0.09	0.00	0.06	0.09	0.08	0.06	0.07	0.16	0.23	0.18	0.22	0.30
2	-0.20	-0.01	0.03	0.07	0.06	0.01	-0.01	0.13	0.22	0.17	0.20	0.29
3	-0.47	-0.20	-0.14	-0.01	-0.12	-0.30	-0.34	-0.03	0.16	0.12	0.18	0.28
4	-0.18	-0.03	0.00	0.03	0.03	-0.09	-0.11	-0.05	0.15	0.10	0.15	0.27
5	-0.48	-0.23	-0.16	-0.10	-0.05	-0.10	-0.12	-0.07	0.13	0.09	0.16	0.26
6	-0.48	-0.19	-0.07	-0.03	0.02	0.02	-0.01	-0.03	0.15	0.15	0.19	0.27
7	-0.43	-0.13	0.01	0.09	0.12	0.12	0.10	0.09	0.23	0.23	0.25	0.30
8	-0.47	-0.10	0.02	0.12	0.19	0.20	0.20	0.23	0.27	0.29	0.31	0.34
9	-0.82	-0.22	-0.07	0.10	0.19	0.20	0.20	0.24	0.27	0.28	0.29	0.33
10	-2.60	-0.33	-0.12	0.07	0.21	0.22	0.20	0.23	0.26	0.24	0.27	0.30
11	-5.13	-1.08	-0.43	-0.02	0.16	0.16	0.13	0.16	0.20	0.17	0.20	0.26
12	-3.44	-1.26	-0.47	-0.05	0.22	0.22	0.19	0.24	0.29	0.27	0.30	0.34

Table 4: T-statistics: Testing Null Hypothesis that the Sum of the Lagged Debt Coefficients is Zero

Lags on Inflation \ Lags on Debt	1	2	3	4	5	6	7	8	9	10	11	12
1	-0.85	0.43	0.46	0.76	0.50	0.37	0.36	0.86	1.37	0.88	1.08	1.75
2	-1.39	-0.03	0.19	0.51	0.34	0.03	-0.03	0.58	1.11	0.67	0.80	1.64
3	-2.06*	-0.84	-0.54	-0.05	-0.32	-0.58	-0.60	-0.08	0.48	0.30	0.49	0.99
4	-1.05	-0.18	0.01	0.17	0.11	-0.25	-0.28	-0.12	0.41	0.22	0.37	0.86
5	-1.71	-0.83	-0.55	-0.31	-0.13	-0.26	-0.28	-0.14	0.33	0.19	0.40	0.76
6	-1.69	-0.69	-0.28	-0.11	0.06	0.07	-0.03	-0.07	0.38	0.36	0.49	0.89
7	-1.59	-0.50	0.02	0.35	0.44	0.46	0.38	0.29	0.82	0.81	0.85	1.15
8	-1.71	-0.44	0.08	0.58	0.93	0.94	0.94	1.07	1.24	1.37	1.40	1.48
9	-1.86	-0.66	-0.23	0.38	0.82	0.87	0.86	0.99	1.15	1.21	1.19	1.24
10	-2.13*	-0.69	-0.29	0.19	0.76	0.76	0.70	0.77	0.88	0.81	0.91	0.83
11	-2.45*	-1.04	-0.58	-0.04	0.43	0.41	0.29	0.39	0.47	0.40	0.47	0.57
12	2.54*	-1.08	-0.61	-0.10	0.69	0.66	0.52	0.68	0.89	0.84	0.91	1.01

* significant at the 5 percent level.

Table 5: Long-run Elasticity Parameters: Responsiveness of Debt to a Permanent Change in Inflation

Lags on Debt \ Lags on Inflation	1	2	3	4	5	6	7	8	9	10	11	12
1	1.07	1.07	1.43	1.49	1.55	1.61	1.78	1.73	1.87	1.92	1.92	2.00
2	1.25	1.25	1.56	1.62	1.64	1.68	1.77	1.74	1.86	1.89	1.89	1.95
3	1.66	1.73	2.01	2.03	2.03	2.06	2.01	1.96	2.05	2.02	2.00	2.05
4	1.73	1.82	2.15	2.15	2.14	2.16	2.04	2.01	2.07	2.05	2.00	2.04
5	1.68	1.75	2.07	2.10	2.11	2.12	2.04	2.03	2.07	2.05	2.00	2.01
6	1.69	1.70	2.03	2.06	2.10	2.10	2.05	2.04	2.06	2.04	1.99	2.00
7	1.69	1.70	2.02	2.05	2.11	2.08	2.10	2.11	2.12	2.09	2.02	2.01
8	1.83	1.80	2.10	2.13	2.17	2.16	2.22	2.50	2.21	2.18	2.10	2.04
9	2.14	2.09	2.41	2.40	2.37	2.37	2.38	2.38	2.34	2.30	2.21	2.10
10	1.97	1.92	2.24	2.27	2.26	2.26	2.28	2.28	2.28	2.28	2.22	2.11
11	1.90	1.87	2.21	2.24	2.26	2.26	2.26	2.26	2.26	2.25	2.25	2.13
12	1.72	1.70	1.98	2.02	2.04	2.03	2.07	2.07	2.08	2.07	2.06	2.04

Table 6: T-statistics Testing Null Hypothesis that the Sum of the Lagged Inflation Coefficients is Zero

Lags on Debt \ Lags on Inflation	1	2	3	4	5	6	7	8	9	10	11	12
1	2.30*	2.15*	3.21*	3.53*	3.69*	3.73*	4.61*	4.13*	4.31*	4.40*	4.46*	5.09*
2	2.29*	2.15*	3.14*	3.48*	3.52*	3.47*	4.47*	3.96*	4.12*	4.29*	4.35*	5.13*
3	2.25*	2.26*	3.23*	3.53*	3.67*	3.31*	4.10*	3.33*	3.49*	3.31*	3.46*	4.23*
4	2.42*	2.46*	3.30*	3.59*	3.72*	3.37*	4.08*	3.27*	3.39*	3.22*	3.36*	4.13*
5	2.45*	2.49*	3.33*	3.52*	3.67*	3.32*	4.05*	3.26*	3.37*	3.17*	3.31*	4.23*
6	2.50*	2.39*	3.22*	3.34*	3.56*	3.29*	4.03*	3.25*	3.36*	3.16*	3.32*	4.21*
7	2.45*	2.34*	3.32*	3.46*	3.88*	3.46*	4.03*	3.24*	3.37*	3.09*	3.18*	4.04*
8	2.30*	2.10*	3.09*	3.46*	3.90*	3.54*	4.02*	3.29*	3.37*	3.12*	3.10*	3.89*
9	1.98	1.81	2.93*	3.22*	3.50*	3.15*	3.67*	3.23*	3.38*	3.12*	3.13*	3.80*
10	2.13*	1.97	2.92*	3.10*	3.44*	3.28*	3.83*	3.43*	3.43*	3.10*	3.12*	3.78*
11	2.13*	1.93	2.84*	3.03*	3.34*	3.21*	3.94*	3.56*	3.67*	3.29*	3.10*	3.77*
12	2.26*	2.09*	3.31*	3.46*	3.72*	3.51*	4.25*	3.91*	4.04*	3.60*	3.35*	3.76*

*Significant at the 5 percent level

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